Measurement of Arterial Pressure Waves and Central Blood Pressure: Opportunities and Challenges

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Based on the expectation that measures of central blood pressure (CBP) and arterial function would be superior to standard sphygmomanometry for predicting cardiovascular risk, a number of devices have been introduced for the noninvasive estimation of CBP and pulse wave velocity (PWV). However, questions have been raised about the validity and reliability of some of the methodologies and about their added clinical value. Consequently, there is currently ambiguity about the introduction of these measurements into routine clinical practice. The American Journal of Hypertension (AJH) welcomes the submission of manuscripts that address these issues.

Theoretically, measurement of CBP may have several advantages over peripheral measurements. Owing to the variable superimposition of incoming and reflected pressure waves in the arterial tree, aortic systolic pressures may differ from conventionally measured brachial pressures. Although central systolic pressure rarely exceeds brachial systolic pressure, peripheral amplification of brachial systolic blood pressure overestimates CBP, especially in young people, and arterial stiffness related to aging is associated with a disproportionate increase of central systolic pressure relative to brachial systolic pressure. Additionally, despite similar reductions in peripheral blood pressure, different classes of antihypertensive agents may have variable effects on CBP.

The gold standard for the measurement of CBP is aortic root blood pressure, using a saline-filled catheter or an external pressure transducer with tip in situ—obviously not practical for routine clinical practice. The most widely used noninvasive approach for the estimation of CBP is to perform radial artery tonometry and then apply a transfer function to calculate the aortic pressure waveform from the radial waveform. Although invasive blood pressure generally performs better in validation studies than noninvasive pressure for calibrating noninvasively acquired pressure waveforms, in the clinical setting, brachial artery pressure is generally used as a surrogate measure of radial pressure for the calibration of central pressure. Although this may be an attractive strategy to assist with the management of hypertension, potential sources of error and variability among devices include the following: (i) calibration of peripheral waveforms by cuff blood pressure measured over the brachial artery; (ii) the quality of the peripheral waveform; and (iii) the robustness of the mathematical modeling of the generalized transfer function for waveform calibration.

Perhaps related to the increased availability of noninvasive measurements, there is also considerable interest in evaluating the contribution of arterial stiffness to the development of isolated systolic hypertension, increased pulse pressure with aging, and cardiovascular disease. Pulsatile blood pressure increases with age, especially in the aorta. Pulsatile components of blood pressure arise from forward (ventricular generated) and backward (reflected) wave travel in the arterial tree. The relative importance and contributions of increased amplitude and timing of forward and reflected waves to elevated pulse pressure remain controversial, possibly due to different methodologies and models for assessing aortic pressure and the magnitude of wave reflection.

The measurement of carotid-femoral PWV is generally accepted as the “gold standard” for determining arterial stiffness. Transit time between the two sites is often recorded with the aid of continuous Doppler probes placed over the carotid and femoral arteries. This approach to measuring PWV has the largest amount of epidemiologic evidence for its predictive value of cardiovascular events, independent of other risk factors, and it requires little technical expertise.

To date, the added predictive value of CBP for cardiovascular events beyond brachial pressure is either marginal or not statistically significant in most studies. However, adapting a Markov model to evaluate a hypothetical primary care population, it has recently been estimated that a CBP strategy is more cost-effective than conventional cuff blood pressures in terms of quality-adjusted life year gains. The 2013 European Guidelines conclude that more investigation is necessary before recommending measurement of CBP for routine clinical use. The added predictive value of PWV above and beyond traditional risk factors has been quantified in a number of studies. However, it remains to be determined whether a reduction of PWV is associated with a reduction of cardiovascular events, independent of reversing classical risk factors. The 2013 European Guidelines give the measurement of PWV relatively enthusiastic endorsements for its cardiovascular predictive value, reproducibility, and cost-effectiveness. Measurements of CBP and PWV are not mentioned in either JNC7 or JNC8, and
there are reimbursement issues associated with these measures.

The AJH invites the submission of original studies and commentaries that will provide new insights about the technology and clinical applications of noninvasive measurements of CBP and peripheral vascular function.

REFERENCES